

Effects of High Water-Absorbing Polymer on Growth and Drought Endurance of Cashew Nut, Green Mango and Para-rubber Under Tropical Field Conditions

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ABSTRACT

Field experiments were conducted during January to May 1988 to study effects of high water-absorbing polymer (HWAP) namely ACRYHOPE on growth, nutrient uptake and drought endurance of para-rubber, (*Hevea brasiliensis* Muell. Arg) variety RRIM 600, cashew nut (*Anacardium occidentale* L.), local variety and green mango (*Mangifera indica* L. cv. Keo-Sawei). The results obtained from trials on clayey soil in Rayong province revealed that irrigation treatments and HWAP application had no or otherwise inconsistent effects on plant dry weight, N, P concentrations in leave and drought endurance of para-rubber and cashew nut. In the Northeast sandy soils in Nakornratchasima and Buriram provinces, HWAP application help stimulated plant growth and increased total N and P uptake in leave of para-rubber, cashew nut and green mango. Except para-rubber, this was also true for the positive effect of HWAP on drought endurance of green mango and cashew nut seedlings. For cashew nut in particular, the beneficial effect of HWAP on drought endurance was very obvious. After planting, most cashew nut seedling treated with HWAP can withstand subsequent long dry spell occurred during the course of growing period studied. Thus significantly increased survival number of the plant against drought

Key words : high water absorbant polymer, drought endurance, para-rubber, cashew nut, green mango

INTRODUCTION

By average, annual rainfall of about 1,100-1,500 mm in all over Thailand is not too low for plant need (Duangpatra, 1987). Despite that fact plant grown during rainy season frequently facing severe moisture stress primarily due to long dry spell prevail within the seasonal period. This erratic rainfall which mainly reflecting from irregular distribution of rain frequently resulting in serious crop damage or even complete crop failure particularly in the Northeast. Beside the impact of drought on field crops which are predominated in the areas, too long dry spell occur during the rainy season also cause drastic loss on newly planted trees or fruit trees in the regions. Long drought period occurs after transplanting frequently resulting in substantial death of newly planted seedling. Consequently, retransplanting has to be done thereafter most likely during the subsequent rainy season in the following year. This increase operating cost, lose chances for establishing plant stand of the same planting age as well as difficulties in procuring plant seedling for replanting. To minimize or prevent this water stress damage, conservative

and efficient use of water particularly of that part leftover from the last rain is of utmost importance. Apparently, one of the potential countermeasure to alleviate this problem is the use of water retaining agents such as high water-absorbing polymers (HWAP). Upon addition to the soil, this material acts as many micro-water dams to retain moisture and gradually release to the plant as need. Investigation in the laboratory had shown that mixing HWAP namely ALCOSORP and VITERRA with various coarse, medium and fine textured soils resulted in substantial increase of plant available water in all soils. (Thammasak, 1990). Under pottrial conditions, several investigations has been accomplished to assess the impact of high water-absorbing polymer on life extension of tree seedling under long and severe soil moisture stress. Conclusively, most of the results obtained clearly signified the beneficial effect of this material on enabling plant seedling to withstand unusually long drought (Attanandana et. al., 1986, 1987). Nevertheless, the investigations on the same aspect under field conditions are rare or practically nil. Need exists to test the agronomic performance of this material under real climatol-

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ogical environment in the field.

During the first half of the year 1987 extending from January to May, a field experiment was established in Rayong province to evaluate the relative effectiveness of HWAP named "ACRYHOPE" on the growth and drought endurance of para-rubber. Generally, the results obtained on the impact of this material on plant endurance to drought was not clear (Duangpatra, et. al., 1987). This was due to insufficient length of drought period occurred during the time frame observed. In order to assess once again the potential use of this ACRYHOPE material on life extension of the just-planted plants seedling under subsequent long and continuous drought period, five field trials put up during January to May 1988 included para-rubber, cashew nut and green mango as the tested crops. In addition to the impact of HWAP on drought endurance of plants the objective of this investigation is also projected to measure plant growth and nutrient uptake of para-rubber, cashew nut and green mango under tropical field conditions.

MATERIALS AND METHODS

During the month from January to May 1988, five field trials were put up in the Northeast and the East to assess the agronomic effectiveness of a high water-absorbing polymer (HWAP) named "ACRYHOPE" on drought endurance and growth of para-rubber (*Hevea brasiliensis* Muell, Arg) variety RRIM 600, cashew nut (*Anacardium occidentale* L.), local variety and green mango (*Mangifera indica* L. cv. Keo-Sawei). In the East at Huaipong Field Crop Research Center in Rayong province, two separated field experiments designed similarly for each crop : para-rubber and cashew nut, were conducted during 10 January 1988 to 29 April 1988. The experimental design was a split plot having 3 irrigation treatments as the main plot and 5 HWAP treatments as the sub-plot. In the Northeast, 3 HWAP treatments in randomized complete block design

were used similarly for all 3 field trials, each for green mango, para-rubber and cashew nut. The detail on field sites and treatment descriptions of all experiments are summarized in the table below;

In the East, irrigation treatment after last watering at planting was done by sprinkle system. Each sub-plot of both crop trials (para-rubber, cashew nut) contained 3 plants, planted at the spacing of 2 x 2 meters. For all the Northeast trials (para-rubber, cashew nut, green mango), 6 plants per plot with the spacing of 3 x 3 meters were used. For all five trials conducted, all other treatments or cultural practices were identical. The plant hole dug was made at about the size of 50 x 50 x 50 centimeter. Based on recommendation made by the Department of Agriculture, rock phosphate powder were applied to all crops at the bottom of each plant hole at 120 grams per plant. The application method of HWAP material comprise 1) mixing method: mixing HWAP thoroughly with the soil backfill of each planting hole and 2) localized placement method : placing all HWAP locally around plant root at about the mid of each dug hole depth. During 4 months of the study period observations were made on 1) plant height 2) dry weight of branch, stem, leave and the whole plant top 3) N, P uptake in plant leave and 4) drought endurance of plant registered as the number of drought days which cause plant dead and percent plant survival from drought.

RESULTS AND DISCUSSION

Field Experiments in the East

The results of field trials carried out in Rayong province are summarized in tables 3 and 4. Generally, irrigation treatments as well as methods and rates of HWAP application had little or otherwise inconsistent effect on dry weight and N, P uptake of para-rubber and cashew nut. As shown in table 3 para-rubber and cashew nut treated with

Trials in the East (Rayong province)		Trials in the Northeast (Nakornratchasima, Buriram Provinces)	
Treatment	Description	Treatment	Description
Irrigation (main plot)	1. No watering 2. Watering every 15 days 3. Watering every 30 days	HWAP application	1. Check (no application) 2. 70 gm/plant, mixing 3. 70 gm/plant, localized
HWAP application (sub-plot)	1. Check (no application) 2. 70 gm/ plant, mixing 3. 140 gm/ plant, mixing 4. 70 gm/ plant, localized 5. 140 gm/ plant, localized		
Replication Tested crops	3 Para-rubber, cashew nut	Replication Tested crops	2 Para-rubber, cashew nut, green mango

Table 1 Physical and chemical characteristics of surface soil (S) and sub-soil (Su) at the experimental sites.

Soil characteristics	Experimental site					
	Burirum province		Nakornratchasima province		Rayong province	
	S	Su	S	Su	S	Su
pH ¹	4.6	4.4	6.6	5.5	4.2	4.1
Organic matter (%) ²	0.5	0.1	0.6	0.4	1.62	0.71
Avalable P (ppm) ³	16	3	40	10	50.6	15.7
Exchangeable K (ppm) ⁴	60	50	140	70	20	40
Exchangeable Ca (ppm) ⁴	140	160	480	400	1600	1080
Mg (ppm) ⁴	25	29	70	50	29	14
Texture	S ⁵	S	S	S	SCL ⁶	SC ⁷

1 Soil : water = 1:1

2 Walkley and Black method

3 Bray-2 method

4 Extracted by NH₄ OAc, 1 N, pH7.0

5 Sandy soil

6 Sandy clay loam

7 Sandy clay

HWAP at 70 gm per plant gave the highest dry weight of branch and stem, leave and the whole plant top. Nevertheless the influence of HWAP rates on N, P concentrations in leave was not striking and consistent. The results obtained revealed that HWAP application particuarly at 70 gm per plant help incresaed dry matter weight of both crops but exerted no beneficial effect on N, P uptake in plant. This lack of response to native-N in the soil and added rock phosphate may attributed to the fact that 1) the duration of

crop growth for 110 days was probably too short to assess the indirect influence of soil moisture retained by HWAP on availability of N and P in the soil 2) chemical N fertilizer was not used in these experiments, thus nitrogen uptake by plant was derived solely from native-N source 3) Feritilizer P added was in the form of rock phosphate of which most P is in water-insoluble form and 4) surface soil contain very high native-P as determined by Bray-2 method (table 1).

Considering the influence of HWAP on drought endurance of para-rubber and cashew nut, it was observed that HWAP addition had no significant effect on extending plant life or prolonging length of drought endurance of both plants. As presented in table 4, all para-rubber plants can withstand drought and still survived at the time of cutting at 110 days after planting. For cashew nut, HWAP applications exerted no beneficial effect on percent survival and length of drought endurance of plant. Nevertheless, the application by localized placement seemed to be superior to that of the mixing method. Apparently, lack of crop response to HWAP addition or in otherwords, insignificant effect of HWaP-absorbed water on plants may attributed to 1) occasional and frequent occurrence of rain after planting during the time frame observed (figure 1) and 2) soil contain much more clay than that of Northesat soils (table 1), thus, the capacity of the soil to retain water is originally high.

Field Experiments in the Northeast

Three field trials were put up in the Northeast. One of which was located at Bhudthaisong district in Burirum province while the other two were laid out at Kamsakaesang district in Nakornratchasima province. The results obtained as shown in table 5 and figure 2 revealed that HWAP addition at 70 gram per plant had significant effect on increasing plant height and leave dry weight of all tested crops particularly the impact on cashew nut was evident. In term of dry leave weight, it was observed that localized

Table 2 Some specifications and element content of highly efficient water-retaining agent "AQUALICCA (GH-1type)" or commercially named "ACRYHOPE".

Specifications	Characteristics
Appearance and shape	White amorphous lumps
pH	7 + 0.5
Absorbent capacity in tapwater (times)	150-250
Average particle diameter (mm)	1-3
Bulk density (g/cc)	0.6-0.9
Chemical form	Crosslinked sodium polyacrylate
Element Composition	Element content
Fe	184 ppm
Cu	36 ppm
Zn, Pb, Cd	nil
P	992 ppm
Na	14.8% by weight

Sources : Nippon Shokubai Kagaku Kogyo Company, Attanandana et. al. 1987.

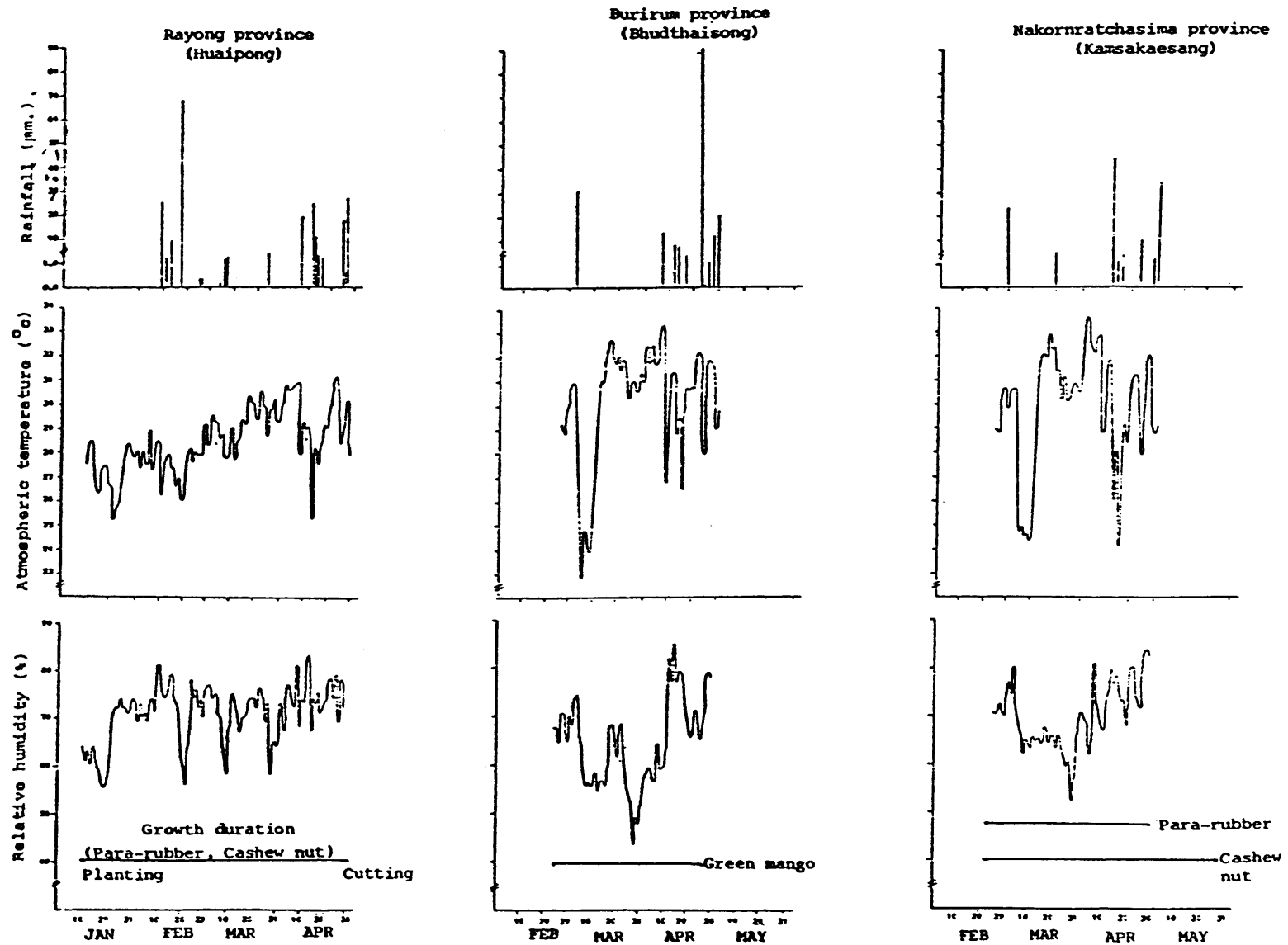


Figure 1 Mean daily precipitation, atmospheric temperature and relative humidity of each experimental site during January 1988 - May 1988.

Table 3 Effects of irrigation interval, methods and rates of HWAP application on dry matter weight and N, P concentration in leaves of para-rubber and cashew nut at 110 days after planting (East, 10 Jan, 1988 - 29 April, 1988).

Irrigation interval (days) ¹	Para-rubber					Cashew nut				
	Dry weight (gm/plant)			N (%)	P (%)	Dry weight (gm/plnat)			N (%)	P (%)
	Branch+Stem (A) ²	Leave (B)	A+B			Branch+Stem (A)	Leave (B)	A+B		
0	7.2	11.9	19.1	0.76	0.13	5.0	9.5	14.5	0.67	0.10
15	8.9	13.2	22.1	0.71	0.14	4.7	8.8	13.5	0.66	0.11
30	6.6	10.3	16.9	0.85	0.13	4.5	7.8	12.3	0.71	0.15
Application method										
Mixing	8.0	12.7	20.7	0.76	0.13	5.0	8.5	13.5	0.66	0.11
Localized	7.9	11.6	19.5	0.80	0.14	4.5	8.8	13.3	0.70	0.14
Application rate (gm/plant)										
0	6.3	10.6	16.9	0.77	0.13	4.9	8.9	13.8	0.68	0.10
70	8.5	12.3	20.8	0.79	0.14	5.1	10.6	15.7	0.67	0.11
140	7.3	12.0	19.3	0.76	0.13	4.4	7.3	11.7	0.68	0.14

1 After planting, irrigation treatments comprise no watering (0) and watering every 15 and 30 days

2 Parts above ground levels

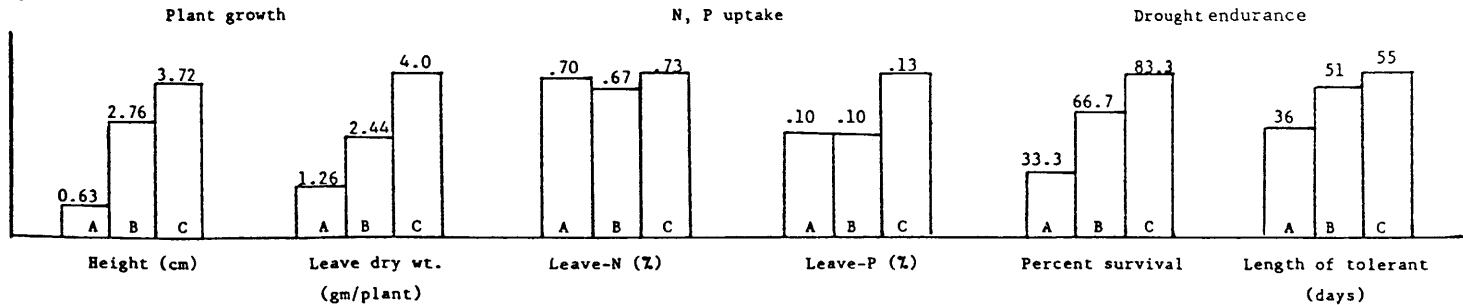


Figure 2 Effects of HWAP application on growth, N, P uptake, and drought endurance of cashew nut at 85 days after planting (Nakornratchasima province, 25 February, 1988 - 29 May, 1988).

Table 4 Effects of irrigation interval and HWAP application on drought endurance of para-rubber and cashew nut at 110 days after planting (East, 10 Jan, 1988 - 29 April, 1988).

Irrigation interval (days)	Total plant grown	Rubber		Cashew nut		
		No. of plant survive	Percent survival	No. of plant survive	Percent survival	Length of drought endurance (days) ¹
0	45	45	100	30	67	63
15	45	45	100	38	84	63
30	45	45	100	28	62	69
Application method						
Mixing	54	54	100	37	68	63
Localized	54	54	100	40	74	67
Application rates (gm/plant)						
0	27	27	100	19	70	68
70	54	54	100	39	72	62
140	54	54	100	38	70	67

¹ Number of days after planting which caused plant dead

placement method was superior to that of the mixing method. By average, HWAP addition had no beneficial effect on increasing N, P concentrations in leave of all plants. Nevertheless, in term of total N and P uptake, since leave dry weights were substantially increased as a result of HWAP addition, therefore, total N and P uptake in leave of treated plants were also increased accordingly.

Data contains in table 6 demonstrated the impact of HWAP addition on drought endurance of green mango, para-rubber and cashew nut. As seen in the table, HWAP application had no beneficial effect on drought endurance of para-rubber neither measuring as percent survival from drought nor in term of the length of drought endurance. For green mango, HWAP application gave slightly higher percentage of plant survival and longer length of drought endurance, whereas the relative effectiveness between the two application methods were comparable. For cashew nut, the influence of HWAP application on drought endurance was very striking. By average, HWAP application at 70 gm per plant resulted in marked increased in percent plant survival from drought as well as length of drought endurance (table 6). Without HWAP application, only one-third or 33.3 percent of plant survived from drought. This figure was doubled with HWAP addition by mixing method (66.7%) and increased even higher upto 83.3 percent by localized placement. This trend was also concurred that of the length of drought endurance data i.e localized method gave the longest length of drought endurance, Comparing the effect between two application methods, plant treated with HWAP by mixing and localized methods could withstand drought to 51 to 55 days after planting, respectively. This was

significantly higher than that of the untreated-plant of which drought endurance period lasted only 36 days.

Lack of significant impact of HWAP application on drought endurance of para-rubber could not be plausibly explain based on data collected. Comparing between the two tree crops (para-rubber, cashew nut) grown under sandy soil and lesser precipitation occurred in Kamsakaessang district, Nakornratchasima province (figure 1), less susceptible to drought of para-rubber than that of cashew nut may partially due to large different in the way plant seedling had been raised. Para-urbber seedling obtained in plastic bag contain large amount of clayey soil adhere tightly to the whole root system whilst growing media for cashew nut seedling contain no clay but small amount of sand and some organic material adhere loosely to the whole root mass. Disregarding of varietal sensitivity to drought of each plant species, this large different in kinds and quantity of root media materials : clay, sand, organic media may help explain more or less the insignificant effect of HWAP application on para-rubber in contradict to obvious positive effect of HWAP on cashew nut.

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Table 5 Effects of HWAP application on height, leave weight and N, P concentrations in leave of green mango, para-rubber and cashew nut at 60, 62 and 85 days after planting respectively (Northeast, 25 February, 1988 - 29 May, 1988)

HWAP application		Buriram province				Nakornratchasima province							
		Green mango				Para-rubber				Cashew nut			
		Height ¹ (cm)	leaveDW (gm/pl)	N (%)	P (%)	Height (cm)	leaveDW (gm/pl)	N (%)	P (%)	Height (cm)	leaveDW (gm/pl)	N (%)	P (%)
0	-	0	12.4	0.41	0.05	0	1.16	0.74	0.13	0.63	1.26	0.70	0.10
70	mixing	0.13	13.0	0.42	0.05	1.41	1.30	0.72	0.15	2.76	2.44	0.67	0.10
70	localized	0.13	16.9	0.39	0.05	2.41	1.47	0.74	0.14	3.72	4.00	0.73	0.13
Average ²		0.13	14.9	0.40	0.05	1.91	1.38	0.73	0.145	3.24	3.22	0.70	1.15

- 1 Plant height increase over plant height at planting
2 Averaging from among HWAP treated-plants only

Table 6 Effects of HWAP application on drought endurance of green mango, para-rubber and cashew nut at 60, 62 and 85 days after planting respectively (Northeast, 25 February, 1988 - 29 May, 1988)

HWAP application		Buriram province				Nakornratchasima province					
		Green mango				Para-rubber			Cashew nut		
		Total plant grown	No. of plant survive	Percent survival	Length of endurance (days) ¹	No. of plant survive	Percent survival	Length of endurance (days)	No. of plant survive	Percent survival	Length of endurance (days)
0	-	12	0	0	32	9	75	53	4	33.3	36
70	mixing	12	2	16.7	33	3	25	44	8	66.7	51
70	localized	12	2	16.7	37	6	50	37	10	83.3	55

- 1 Average length of drought endurance of dead plants.

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